

## XIX. STUDIES ON THE ANATOMY OF INDIAN MOLLUSCA.

### 3. THE SOFT PARTS OF SOME INDIAN UNIONIDAE.

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Ortmann<sup>1</sup> writing in 1911 about the glochidia of the Unionidae summed up in the following sentence, "I have no doubt that this finally will be a very important systematic criterion, but unfortunately we do not know the glochidia of a single Asiatic species." Since then I have in two papers<sup>2</sup> described the structure of the marsupia and glochidia of the Indian genera *Physunio*, *Parreyssia*, *Lamellidens* and *Indonaia*. The results of my work have amply justified Ortmann's criticism<sup>3</sup> of Simpson's classification,<sup>4</sup> in which shell-characters alone were utilised to a large extent for the classification of the Naiades. On studying the soft parts of the animals of the genera *Physunio*, *Lamellidens*, *Parreyssia* and *Pseudodon* it was found that the position assigned to those genera, from shell-characters only, was quite wrong, while two new genera *Indonaia* and *Balwantia* had to be established for the Indian species hitherto included in the genera *Nodularia* and *Solenaia* respectively.

In my second paper I included a description of the soft parts of the animal of *Indonaia*, but refrained from discussing these in the other genera as Dr. Ekendranath Ghosh was engaged in a study of the comparative anatomy of some of the forms. His results, however, which were published in a recent paper,<sup>5</sup> are far from complete from the point of view of the systematist and many important details are neither mentioned in the text nor shown in the figures. In the present communication I have, therefore, tried to ratify these omissions for the genera dealt with by Ghosh, and have in addition given descriptions of the animals of the genera *Parreyssia* and *Pseudodon*. In dealing with the various genera I have discussed their position in both Simpson's and Ortmann's classifications, and at the end of the paper I have given a key for the identification of these genera based on the soft parts of the animals.

<sup>1</sup> *Ann. Carnegie Mus.*, VIII, p. 239 (1911-12).

<sup>2</sup> *Rec. Ind. Mus.*, XIV, pp. 183-185, pl. xxii (1918), and *ibid.*, XV, pp. 143-149 (1918).

<sup>3</sup> *Mem. Carnegie Mus.*, IV, pp. 279-347, pls. lxxxvii-lxxxix (1911).

<sup>4</sup> *Proc. U.S. Nat. Mus.*, XXII, pp. 501-1075 (1900).

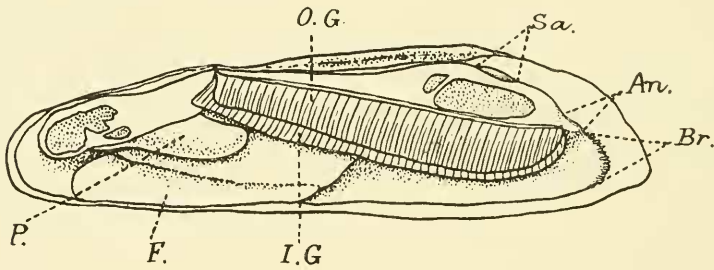
<sup>5</sup> *Rec. Ind. Mus.*, XV, pp. 109-123, pl. xvi (1918).

**Balwantia**, gen. nov.

Ghosh (*loc. cit.*) has recently described the gross anatomy of the species *Solenaiia soleniformis* (Benson) in a comparative way only. Godwin-Austin and Annandale<sup>1</sup> have since added valuable notes on the habits and burrows of the animal and this discussion of the habits has brought out interesting facts about the use of the very large and well-developed foot. On comparison of the anatomy of the Indian species with that of the other known species of the genus *Solenaiia*, Conrad, it was found that the former differs materially from the others and must be separated as a distinct genus. The question of the name of this genus is discussed at length below.

*Animal*.—In accordance with the greatly elongated condition of the shell, the animal (fig. 1) also is drawn out in the antero-posterior axis, as are organs like the gills, palps, foot, etc.

The gills are eight to ten times as long as broad, the inner pair being a little wider than the outer. The inner lamellae of



TEXT-FIG. 1. —Animal of *Balwantia soleniformis*. An. = anal aperture; Br. = branchial aperture; F. = foot; I.G. = inner gill; O.G. = outer gill; P. = palp; Sa. = supra-anal.

the inner pair are attached to the abdominal sac along more than half of their anterior portion; posteriorly the lamellae of the two sides unite with one another to form the diaphragm, which extends on either side up to a ridge of the mantle that separates the branchial from the anal aperture. Other attachments of the gills are the same as in some of the more primitive genera, *viz.* the outer lamellae of the outer pair of gills are attached to the mantle of either side, while the inner lamellae of the outer pair are attached to the outer lamellae of the inner pair. All the four gills are marsupial and are used for the development of the glochidia. The free margins of the gills do not swell up when the gills are filled with glochidia. The water-tubes are simple, formed of 17-20 gill-filaments each; the number in each gill, however, is variable. The placentae are of the shape of inverted triangles. The palpi are very large elongate-elliptical in outline; the axis of

<sup>1</sup> *Rec. Ind. Mus.*, XVI, pp. 204-206 (1910).

attachment is rather short. The foot is very large and has a well developed musculature. The mantle has a very much thickened entire margin; near the branchial aperture it has a few papillae developed on its edge. The branchial aperture is large, with two to three rows of large conical papillae; its margin is of a yellowish-brown colour. The anal aperture is about half the size of the branchial; it is quite smooth and much lighter in colour. Separating the branchial from the anal is a well-developed ridge of the mantle; in the living animal the ridges of the opposite sides, meeting each other in the middle, would form a continuation of the diaphragm and completely separate the branchial from the anal aperture. The supra-anal is slightly larger than the anal, while the mantle connection between it and the anal is much larger than either.

The glochidium (fig. 2) may be said to be suboval in outline, with a nearly straight hinge line. It measures .26 mm.  $\times$  .21 mm.

*Systematic position*.—The species was originally described by Benson<sup>1</sup> as *Anodonta soleniformis*.

Lea<sup>2</sup> considered it to be a *Margarona* and redescribed it as *M. (Unio) ben-soni*. Hauley and Theobald,<sup>3</sup> differing from both authors, included it in the African genus *Spatha*. Fischer,<sup>4</sup> after an elaborate discussion of the whole situation, assigned it to the genus *Mycetopus*. Simpson<sup>5</sup> in



TEXT-FIG. 2.—Glochidium of *Balwantia soleniformis*,  $\times$  75.

his monograph separated it from the genus *Mycetopus* and included it, with a number of species from China, Siam, South Eastern Asia and a doubtful one from Australia, in the genus *Solenaia*. Preston<sup>6</sup> has, following Simpson, described it as *S. soleniformis* (Benson); some of his references to the previous works, however, are incorrectly cited. The animal of the Indian species is quite different from that of a species of *Solenaia* described by Fischer (*loc. cit.*, p. 11). I have, therefore, found it necessary to separate the only known Indian species as a new genus, for which the name *Balwantia* is proposed.

Simpson was right in including the species in the sub-family Unioninae and in the group Exobranchiae, but made a mistake in assigning it to the subgroup Homogenaie, because, as has been described above, this species carries the glochidia in all the four gills and should be placed amongst the Tetragenae. Following the later and more natural classification of Ortmann (*loc. cit.*, pp. 224-225) the genus will be placed in the family Unionidae, Swainson, as restricted by Ortmann, and in the sub-family Unioninae.

<sup>1</sup> *Journ. Asiat. Soc. Bengal*, V, p. 750 (1836).

<sup>2</sup> *Lea, Syn.*, p. 57 (1870).

<sup>3</sup> *Conch. Ind.*, p. 5, pl. ix, fig. 1 (1876).

<sup>4</sup> *Journ. Conchylol.*, XXXVIII, pp. 11, 94 (1890).

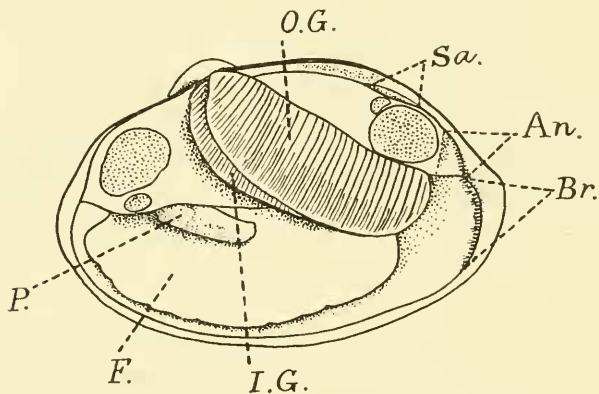
<sup>5</sup> *Proc. U.S. Nat. Mus.*, XXII, p. 656 (1900).

<sup>6</sup> *Faun. Brit. Ind., Mollusca*, pp. 132-134 (1915).

**Parreyssia**, Conrad.

Ortmann<sup>1</sup> has described the animals of this genus and of *Lamellidens*. I have unfortunately not been able to see the original papers but have consulted his later publication,<sup>2</sup> in which he has given a fairly complete résumé of his first paper.

The animal (fig. 3) may be described as follows:—The gills are three to five times as long as broad. Anteriorly the outer pair of gills is a little shorter than the inner, so that the margin of the latter projects beyond that of the former. The inner lamellae of the inner pair of gills are connected along more than three fourths of their length to the abdominal sac; the posterior one fourth part unites with the lamella of the opposite side to form the diaphragm; other connections of the gills are the same as in *Balwantia* described already. All the four gills are marsupial. The margin of



TEXT-FIG. 3.—Animal of *Parreyssia fuvidens*, reference lettering same as in fig. 1.

the gills, even when full of glochidia, is quite sharp. The water-tubes are simple and the placentae are slightly compressed, elongate structures. The palpi are well developed, sub-triangular with a broad base, along which they are attached to the abdominal mass and have the free outer angle rounded. The mantle has a slightly thickened entire margin. The foot is very large, occupying about half of the shell cavity. The branchial aperture is large with three rows of small pointed papillae of a light brown colour. The anal is less than half the size of the branchial and is marked off from it by a feebly developed ridge of the mantle. The supra-anal is of the same size or a little larger than the mantle connection between it and the anal.

The glochidia<sup>3</sup> are semi-circular or semi-elliptic.

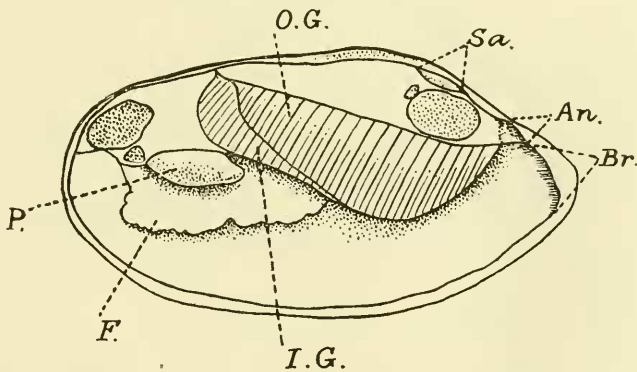
<sup>1</sup> *Nautilus*, XXIII, pp. 130-142 (1910) and XXIV, pp. 103-108 (1911).

<sup>2</sup> *Ann. Carnegie Mus.*, VII, pp. 222-365 (1911-12).

<sup>3</sup> *Rec. Ind. Mus.*, XV, pp. 145-146 (1918), may be consulted for details.

**Lamellidens, Simpson.**

The animal (fig. 4) may be described as follows:—The gills are much broader in the posterior than in the anterior half of their length, and the inner pair is broader than the outer throughout. The inner lamellae of the inner pair of gills are attached to the abdominal mass along more than half of their length anteriorly, and posteriorly they are united with one another to form the diaphragm. Only the outer pair of gills are marsupial,<sup>1</sup> the entire length of the gills being filled up with glochidia and the margin of the gills remaining sharp even when they are quite full of glochidia. The water-tubes are simple, and the placentulae are flat elliptic plates, thick and broad above, thin and tapering below. The palpi are rhomboidal with the angles rounded, and are attached along one of the longer sides. The margin of the mantle is entire and slightly thickened beyond the pallial con-



TEXT-FIG. 4.—Animal of *Lamellidens marginalis*, reference lettering same as in fig. 1.

nection. The foot, which is elongate, is not very large. The branchial aperture is comparatively large with two to three rows of well-developed pointed papillae, and is of a brownish colour. The anal is very much smaller than the branchial and has a row of small papillae along the margin. In continuation of the attachment of the diaphragm to the mantle of each side is a feebly developed ridge separating the branchial from the anal aperture. The supra-anal is a little larger than the anal and of about the same size as the mantle connection between the two apertures.

The glochidia are semi-elliptic in outline.

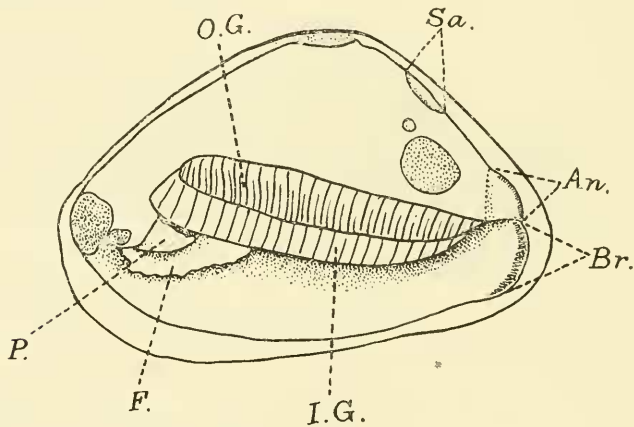
<sup>1</sup> For further details about the marsupium and glochidia see p. 145 of my second paper (*Rec. Ind. Mus.*, XV). Unfortunately there is a typographical error in the statement about the margins of the gills, which reads 'sharp and distended' instead 'of sharp and not distended.'



**Physunio**, Simpson.

Ghosh (*loc. cit.*, p. 112) has described the gills of the animals of two species of this genus, but the structures are variable.

The animal (fig. 5) may be described as follows:—The gills are much broader in the anterior than the posterior half and the outer pair is much smaller in breadth than the inner, so that the latter projects below it all along. The attachments of the gills are similar to those in *Parreyssia* and *Lamellidens*, except that the portion of the inner lamellae of the inner pair of gills, which is attached to the abdominal sac, is much less than half their length. Only a portion of the outer pair of gills is marsupial, a small anterior and a much larger posterior portion of them remaining unmodified for respiratory purposes; the marsupial part is formed by 11-17 simple water-tubes. The free margin of the marsupial part of the gills in this genus also remains sharp.<sup>1</sup> The outlines of the placentulae



TEXT-FIG. 5.—Animal of *Physunio ferrugineus*, reference lettering same as in fig. 1.

cannot be definitely described, as the glochidial membranes are very loosely attached to one another and a compact structure is not formed. The palpi are triangular with the apex rounded and attached by a broad base. The margin of the mantle is feebly thickened and is entire. The foot is comparatively small in preserved specimens, though it is an important organ for burrowing in the mud.<sup>2</sup> Dr. Annandale tells me that it is capable in life of considerable expansion. The branchial aperture is about one and a half times as large as the anal, and its margin has three rows of elongated tubercles. The mantle ridge separating the branchial from the anal aperture is well developed, but small, owing to the diaphragm extending to very near the margin. The mantle con-

<sup>1</sup> Detailed description of the marsupium, etc., is given in my paper *Rec. Ind. Mus.*, XIV, pp. 183-185 (1918).

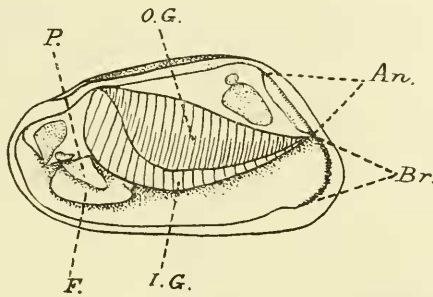
<sup>2</sup> See Annandale, *Rec. Ind. Mus.*, XIV, p. 141 (1918).

nection between the anal and supra-anal is of about the same size as the anal and the supra-anal also is not much larger.

The glochidia are semi-circular.

### **Pseudodon (Pseudodon), Gould.**

Deshayes and Julien<sup>1</sup> published a fairly good figure of the animal of *P. moreleti*, Crosse and Fischer, but gave no description; the figure also, owing to its being drawn from the lower surface, does not show some important details. Simpson from this figure described (*loc. cit.*, p. 834) the animal as follows: "Animal having the branchiae wide and rounded behind, becoming narrow in front; palpi enormously long, apparently slender, pointed behind where they project free for some distance, mantle thin with slightly thickened border, faintly papillose behind, there seeming to be but little distinction between anal and branchial openings; anal opening apparently smooth." Unfortunately no more in-



TEXT-FIG. 6.--Animal of *Pseudodon salvenianus*, reference lettering same as in fig. 1.

formation can be got from Deshayes and Julien's figure and such important points as the presence or absence of a supra-anal, the mantle connection between the anal and supra-anal and even the distinction between the anal and branchial apertures cannot be made out. Simpson placed *P. moreleti* in the section *Pseudodon*, but the animal of *P. salvenianus* described below differs materially from that of the other known species of this section, and as *P. salvenianus* is the type-species of the section *Pseudodon*, it seems that the whole grouping requires revision.

In Simpson's classification the genus is included amongst the Endobranchiae, but the marsupium in *P. salvenianus*, at any rate, is formed by all the four gills and hence it should be included amongst the Exobranchiae, Homogenaee. In Ortmann's classification it will be included in the family Unionidae and the sub-family Unioninae.

<sup>1</sup> *Nouv. Arch. du Mus.*, X, pl. v, fig. 3 (1874).

The following description of the animal (fig. 6) is based on a few small spirit specimens in the collection of the Zoological Survey of India, collected by Dr. A. R. S. Anderson in the year 1898 at Ye-Bu, Tenasserim, Burma.

The gills are rather broad; the inner pair being all along broader than the outer, more so in the anterior half than in the posterior. The inner lamellae of the inner pair of gills are attached to the abdominal sac along the anterior third only; posteriorly they are united with one another to form an elongated diaphragm extending to very nearly the margin of the mantle. The marsupium is formed by all the four gills, which have a sharp free margin. The water-tubes are simple and the placentae elliptical. The triangular palpi are not very large. The free margin of the



TEXT-FIG. 7.—Glochidium of *Pseudodon salvenianus*,  $\times 75$ .

mantle is entire and only slightly thickened. The foot is comparatively small. The branchial opening is large with well developed papillae. The anal aperture, owing to the absence of a mantle connection, is very large and extends to the point where the supra-anal would be; it is papillose only in the lower one-fourth of its extent. The ridge of the mantle separating the branchial from the anal is very small and poorly developed.

The glochidia (fig. 7) are sub-circular, measuring  $\cdot 19$  mm.  $\times$   $\cdot 18$  mm.

#### SYNOPTIC TABLE FOR THE VARIOUS GENERA.

A. No supra-anal aperture	...	...	...	<i>Pseudodon</i> .
B. A distinct supra-anal separated from the anal by a mantle connection				
I. Marsupium formed by all the four gills.				
a. Gills 8-10 times as long as broad	..	...	...	<i>Balwantia</i> .
b. Gills not more than 5 times as long as broad.				
1. Inner pair of gills much broader than outer throughout their length	...	...	...	<i>Indonaia</i> <sup>1</sup> .
2. Inner pair of gills nearly as broad as the outer except in the anterior part	...	...	...	<i>Parreyssia</i> .
II. Marsupium formed by the outer pair of gills only.				
a. Entire length of the outer pair of gills marsupial	...	...	...	<i>Lamellidens</i> .
b. Gills modified for marsupial function only near the middle of the outer pair	...	...	...	<i>Physunio</i> .

<sup>1</sup> See also Ortmann, *Nautilus*, XXXI, pp. 128-131 (1918). I have been able to consult all original papers by Ortmann since this paper was sent to press.